

**Unit  
05**

## CELL CYCLE

**Q.1. Define reproduction. Describe its importance in life.**

**Ans.** The most basic characteristic of life is reproduction.

**Definition**

It is a biological process in living things by which they produce their young ones which are similar to parents.

**Levels of Reproduction**

Reproduction occurs at different levels of organization.

- (i) Parts of the cell such as the chromosomes produce new chromosomes.
- (ii) Cells then produce new cells
- (iii) Individuals produce offsprings like themselves.

**Reproduction for continuation of life**

Rudolf Virchow proposed an important biological principle that all cells come from pre-existing cells. This principle tells us that the continuation of life, including all aspects of reproduction, is based on the reproduction of cells. We commonly refer cellular reproduction as cell division and it is a part of whole life of a cell i.e. cell cycle.

**Q.2. Define cell cycle. Describe its phases.** (Lahore board 2011 G II)**Ans. Definition:**

Cell cycle is the series of events from the time a cell is produced until it completes mitosis and produces new cells.

**Phases of cell cycle**

The cell cycle consists of two major phases i. e.

- (i) Interphase
- (ii) Mitotic phase (M phase)

The mitotic phase is a relatively short period of cell cycle. It alternates with the much longer interphase, where the cell prepares itself for division. Typically interphase lasts for at least 90% of the total time required for cell cycle.

**Q.3. Define interphase. Explain the stages of interphase.** (Lahore board 2011 G II)**Ans. Definition:**

Interphase is the time when a cell's metabolic activity is very high, as it performs its various functions.

### Stages of interphase

It is divided into three phases.

**G1** (first gap)

**S** (synthesis)

**G2** (second gap)

#### G1 Phase

After its production, a cell starts its cell cycle in G1 phase. During this phase,

- (i) The cell increases its supply of proteins,
- (ii) Cell increases the number of its organelles (such as mitochondria, ribosomes)
- (iii) Cell grows in size.

(iv) This phase is also marked by the synthesis of various enzymes that are required in the next phase i.e. S phase, for the duplication of chromosomes.

#### S Phase

In this phase, DNA replication takes place, as a result the cell duplicates its chromosomes.

As a result, each chromosome consists of two sister chromatids.

#### G2 Phase

In the G2 phase, the cell prepares proteins that are essential for mitosis, mainly for the production of spindle fibres.

After the G2 phase of interphase, the cell enters in the division phase i.e. M phase. It is characterized by mitosis, in which the cell divides into the two daughter cells.

#### Q.4. Write a brief note on G0 Phase.

#### Ans. G0 Phase

#### Eukaryotic or Multicellular Cells

##### Definition

Cells that have temporarily or permanently stopped dividing are said to have entered a state of quiescence called G0 Phase.

In multicellular eukaryotes, cells enter the G0 state from G1 and stop dividing. Some cells remain in G0 for indefinite period e.g. neurons. Some cells enter G0 phase semi-permanently e.g. some cells of liver and kidneys. Many cells such as epithelial cells, do not enter G0 and continue to divide throughout an organism's life.

**Note:** The events of cell cycle are ordered

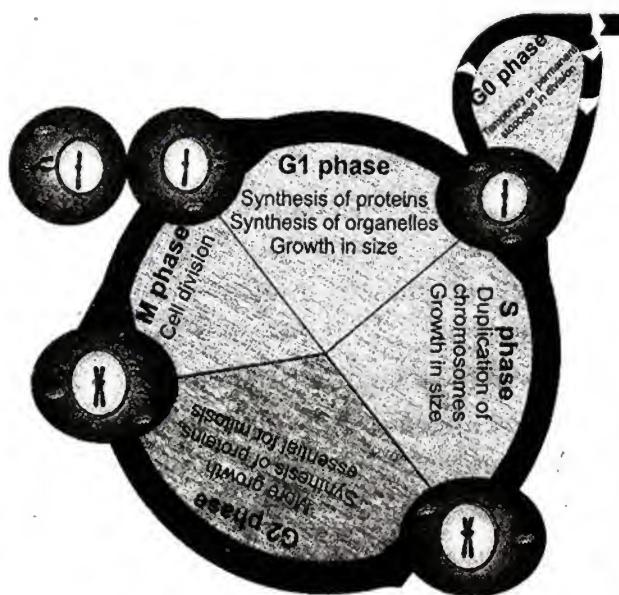


Figure 5.1: The eukaryotic cell cycle

and directional i.e. each event occurs in a sequential fashion and it is impossible to “reverse” the cycle.

#### **Q.5. What do you know about M-Phase?**

**Ans.** After the G<sub>2</sub> Phase of interphase, the cell enters the division phase i.e. M-phase. It is characterized by mitosis, in which cell divides into two daughter cells.

#### **Q.6. What is mitosis? Describe its discovery and phases.**

##### **Ans. Definition**

Mitosis is the type of cell division in which a cell divides into two daughter cells, each with the same number of chromosomes as were present in parent cell.

##### **Discovery of Mitosis**

A German biologist Walther Flemming in the 1880's observed that in a dividing cell, the nucleus passes through a series of changes which he called mitosis.

##### **Occurrence of Mitosis**

Mitosis occurs in eukaryotic cells. In multicellular organisms, the somatic cells undergo mitosis. Prokaryotic cells undergo a process similar to mitosis called binary fission.

##### **Somatic Cells and Germ line Cells**

Somatic cells are those which are forming the body of organisms while germ line cells are those which give rise to gametes. Somatic cells undergo mitosis while germ line cells undergo meiosis.

#### **Phases of Mitosis**

The process of mitosis is complex and highly regulated. The sequence of events is divided into two major phases

- (i) The division of the nucleus is known as Karyokinesis.
- (ii) The division of the cytoplasm is known as cytokinesis.

##### **(i) KARYOKINESIS**

The division of the nucleus is further divided into four phases

- (i) Prophase
- (ii) Metaphase
- (iii) Anaphase
- (iv) Telophase

##### **(i) Prophase**

Following changes occur in the nucleus during prophase.

##### **(i) Condensation of chromatin**

Normally, the genetic material in the nucleus is in a loose thread like form called **chromatin**. At the onset of prophase, chromatin condenses into highly ordered structures called chromosomes.

**(ii) Structure of Chromosomes**

Since the genetic material has already been duplicated earlier in S Phase, each chromosome is made of two sister chromatids, bound together at the same centromere. Each chromosome also has kinetochore at the centromere. A **kinetochore** is a complex protein structure that is the point where spindle fibers attach.

**(iii) Duplication of Centrioles**

There are two centrioles close to the nucleus which are collectively called centrosome. Each centriole duplicates and thus two daughter centrosomes are formed.

**(iv) Formation of Mitotic Spindle**

Both centrosomes migrate to the opposite poles of cell. The two centrosomes give rise to microtubules by (joining) the **tubulin protein** present in the cytoplasm. The microtubules thus formed are called spindle fibers and the complete set of the spindle fibres is known as mitotic spindle.

**(v) Disappearance of Nucleolus and Nuclear Envelope**

The nucleolus and the nuclear envelope have degraded and spindle fibres have invaded the central space.

**(vi) Formation of Spindle fibres in plant cells**

In highly vacuolated plant cells, the nucleus has to migrate into the centre of the cell before prophase. The cells of plants lack centrioles. So, spindle fibres are formed by the aggregation of tubulin proteins on the surface of the nuclear envelope during prophase.

**(ii) Metaphase****(i) Attachment of kinetochore fibres**

When the spindle fibres have grown to sufficient length, some of the spindle fibers, known as kinetochore fibres attach with the kinetochores of chromosomes. Two kinetochore fibres from opposite poles attach with each chromosome.

**(ii) Formation of metaphase plate**

Chromosomes arrange themselves along the equator of the cell forming a metaphase plate. A number of other fibres (non kinetochore) attach with each other from the opposite centrosomes.

**(iii) Anaphase****(i) Separation of sister chromatids**

When a kinetochore spindle fibre connects with the kinetochore of the chromosome, it starts to pull towards the originating centrosomes. The pulling force divides the chromosomes' sister chromatids, and they separate. These sister chromatids are now sister chromosomes, and they are pulled apart towards the respective centrosomes. The other spindle fibres (non-kinetochore) also elongate.

### (ii) Formation of two identical set of chromosomes

At the end of anaphase, the cell has succeeded in separating identical copies of chromosomes into two distinct groups at the opposite poles.

### (iv) Telophase

Telophase is a reversal of prophase. A new nuclear envelope forms around each set of separated chromosomes. Both sets of chromosomes, now surrounded by new nuclear envelopes, unfold back into chromatin. Nuclear division is completed, but cell division has yet one more step to complete.

### (ii) Cytokinesis (Lahore board 2012 G I)

Cytokinesis is the division of cytoplasm.

## CYTOKINESIS IN ANIMAL CELL

In animal cells, cytokinesis occurs by a process known as cleavage. A cleavage furrow develops where the metaphase plate used to be. The furrow deepens and eventually pinches the parent cell into two daughter cells.

## CYTOKINESIS IN PLANT CELL

Cytokinesis in plant cells occurs differently. Vesicles derived from the Golgi apparatus move to the middle of the cell and fuse to form a membrane bounded disc called the cell plate or **Phragmoplast**. The plate grows outward and more vesicles fuse with it. Finally, the membranes of the cell plate fuse with the plasma membrane and its contents join the parent cell wall. The result is two daughter cells, each bounded by its own plasma membrane and cell wall.

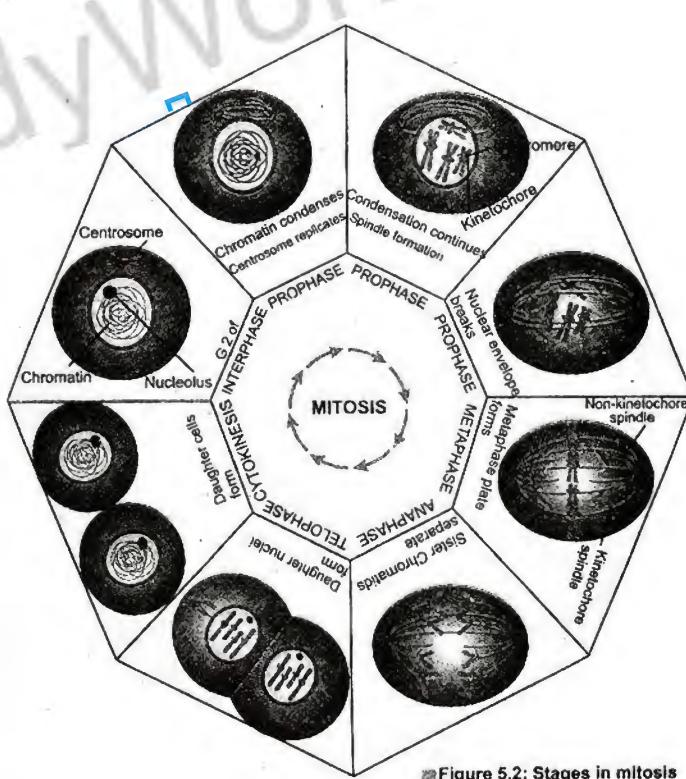


Figure 5.2: Stages in mitosis

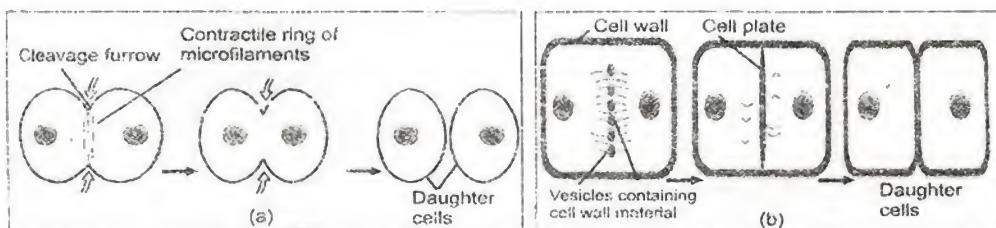


Figure 5.3: Cytokinesis; (a) in animal cell, (b) in plant cell

### Q.7. Describe the significance of mitosis?

**Ans.**

#### (i) Maintenance of chromosome set

The importance of mitosis is the maintenance of the chromosomal set i.e. each daughter cell receives chromosomes that are alike in composition and equal in number to the chromosomes of the parent cell.

#### (ii) Development and growth

The number of cells within an organism increase by mitosis and this is the basis of the development of a multicellular body from a single cell i.e. zygote and also the basis of the growth of multicellular body.

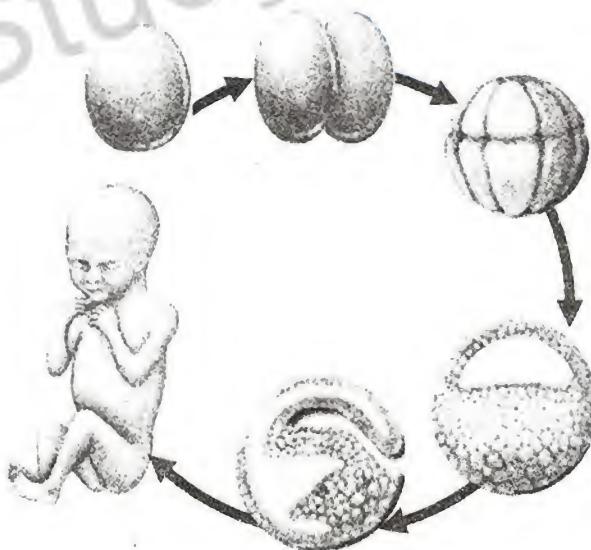


Fig. 5.4: Development of a single cell (Zygote) into a multicellular body

#### (iii) Cell replacement

Cells are constantly sloughed off, and replaced by new ones in the skin and digestive tract.

#### (iv) Repairing of damaged tissues

When damaged tissues are repaired, the new cells are formed by mitosis and so are exact copies of the cells being replaced.

#### Replacement of red blood cells

Red blood cells have short life spans of about 4 months and need to be replaced constantly by mitosis.

#### (v) REGENERATION

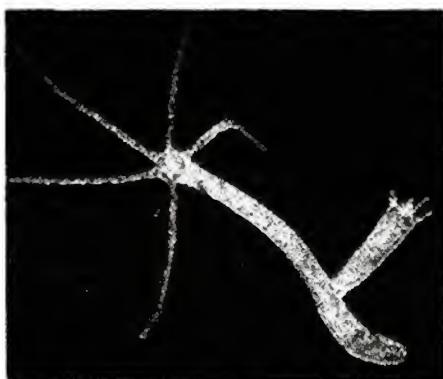
Some organisms can regenerate parts of the body. The production of new cells is achieved by mitosis. For example; sea star regenerates its lost arm through mitosis.



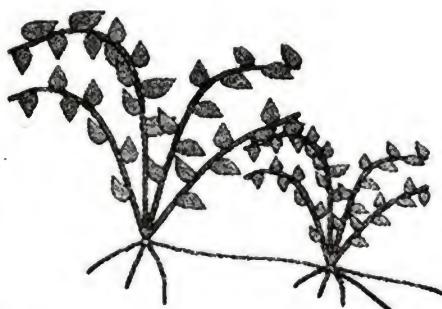
Fig. 5.5 Regeneration in sea

#### (vi) ASEXUAL REPRODUCTION

Some organisms produce genetically similar offspring through asexual reproduction. Mitosis is a mean of asexual reproduction. For example; hydra reproduces asexually by budding. The cells at the surface of hydra undergo mitosis and form a mass called bud. The mitosis continues in the cells of the bud and it grows into a new individual. The same happens during asexual reproduction (vegetative propagation) in plants.



Budding in hydra



Vegetative propagation in plants

**Figure 5.6: Asexual reproduction**

**Q.8. What errors are associated with mitosis?****Ans.****(i) Tumors Formation**

Errors in the control of mitosis may cause cancer. All cells have genes that control the timing and number of mitosis. Sometimes mutations occur in such genes and the cells continue to divide. It results in growth of abnormal cells called tumors.

**Types**

Tumors are of two types.

**(i) Benign tumors**

As long as the tumors remain in their original location, they are called benign.

**(ii) Malignant tumors**

If the tumors invade other tissues, they are called malignant (cancerous) and their cells are called cancer cells.

Malignant tumors can send the cancer cells to other parts in the body where new tumors may form. This phenomenon is called **metastasis (spreading of disease)**.

**Q.9. Define meiosis and explain its phases in detail.****Ans. Definition**

“Meiosis is the process by which one diploid eukaryotic cell divides to generate four haploid daughter cells”.

**Diploid** means the cells in which chromosomes are in pairs (homologous pairs) while **haploid** means the cells with half the number of chromosomes i. e. chromosomes are not in the form of pairs.

**Meaning of “Word Meiosis”**

The word meiosis comes from the Greek word “meioun” meaning “to make smaller” since it results in a reduction in chromosome number.

**Discovery of meiosis**

Meiosis was discovered and described for the first time in 1876, by a German biologist **Oscar Hertwig**.

**Interphase**

The preparatory steps of meiosis are identical to the interphase of mitosis. Interphase is divided into the same three phases i.e. G<sub>1</sub>, S phase and G<sub>2</sub>. Interphase is followed by meiosis I and meiosis II.

**Meiosis I**

In meiosis I, the homologous chromosomes in a diploid cell separate and so two haploid daughter cells are produced. It is the step in meiosis that generates genetic variations. Meiosis I occurs in two main steps i. e. Karyokinesis and Cytokinesis.

## Karyokinesis

The division of nucleus in meiosis I is further divided into four phases:

- (i) Prophase I              (ii) Metaphase I
- (iii) Anaphase I            (iv) Telophase I

### **(i) Prophase I**

Prophase I is the longest phase in meiosis. It consists of the following steps;

#### **(i) Condensation of chromosomes and formation of tetrad**

During this stage, chromatin condenses into chromosomes. The homologous chromosomes line up with each other and form pairs by a process called synapsis. Each pair of homologous chromosomes is said to be **bivalent**. Each bivalent has four chromatids, so it may also be called a tetrad.

#### **(ii) Chiasmata formation during synapsis**

The two non sister chromatids of homologous chromosomes join each other at certain points along their length. These points of attachment are called chiasmata.

#### **(iii) Crossing over**

In the next stage, the non sister chromatids of homologous chromosomes exchange their segments and the phenomenon is known as crossing over.

The exchange of segments results in the recombination of genetic information. After, crossing over, each pair of homologous chromosomes remain as a bivalent.

**Note:** This phenomenon was observed by an American geneticist

Thomas Hunt Morgan in 1911 in fruitfly *Drosophila melanogaster*.

#### **(iv) Other changes during prophase I**

- (i) Chromosomes condense further.
- (ii) The nucleoli disappear.
- (iii) The nuclear envelope disintegrates.
- (iv) Centrioles, which were duplicated during interphase, migrate to the two poles and form spindle fibres.
- (v) The kinetochore spindle fibres attach to the kinetochores of chromosomes.
- (vi) While the non-kinetochore spindle fibres from both sides interact with each other.
- (vii) Two kinetochore spindle fibres attach with a pair of chromosomes.

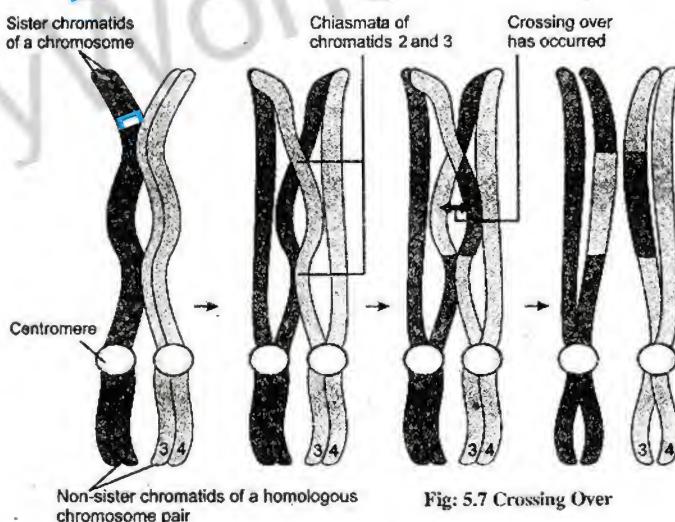


Fig: 5.7 Crossing Over

**(ii) Metaphase I**

The pairs of homologous chromosomes align along an equatorial plane forming the metaphase plate.

**(iii) Anaphase I**

Kinetochore spindle fibres shorten, it results in pulling homologous chromosomes apart of each pair. Since, one chromosome (two chromatids) is pulled toward one pole, forming two haploid sets. Each chromosome still contains a pair of sister chromatids.

**(iv) Telophase I**

The chromosomes arrive at the poles. Each pole now has half the number of chromosomes but each chromosome still consists of a pair of chromatids. The spindle network disappears, and a new nuclear envelope is formed around each haploid set. Chromosomes uncoil back into chromatin.



Fig: 5.8 Stages in Meiosis-1

**Cytokinesis**

Cytokinesis, the pinching of the cell membrane in animal cells or the formation of the cell wall in plant cells occurs, completing the creation of two haploid daughter cells.

**Interkinesis or interphase II**

After meiosis I, both haploid daughter cells enter a period of rest known as interkinesis or interphase II. The interphase II is different from the interphase of mitosis and meiosis I. There is no S-phase and so no duplication of chromosomes during this stage.

## Meiosis II

It is the second part of the meiotic process. Much of this part is similar to mitosis. It is subdivided into

- (i) Prophase II
- (ii) Metaphase II
- (iii) Anaphase II
- (iv) Telophase II

### **(i) Prophase II**

Prophase II takes much less time as compared to prophase I. In this prophase, the nucleoli and the nuclear envelope disappear and the chromatin condenses. Centrioles move to the polar regions and make spindle fibres.

### **(ii) Metaphase II**

In metaphase II, the chromosomes attach with the kinetochore spindle fibres and align at the equator of the cell.

### **(iii) Anaphase II**

In anaphase II, the centromeres are cleaved and sister chromatids are pulled apart. The sister chromatids are now called sister chromosomes and they are pulled towards opposing poles.

### **(iv) Telophase II**

The telophase II is marked with uncoupling of chromosomes into chromatin. Nuclear envelope reforms. Cleavage or cell wall formation eventually produces a total of 4 daughter cells, each with a haploid set of chromosomes.

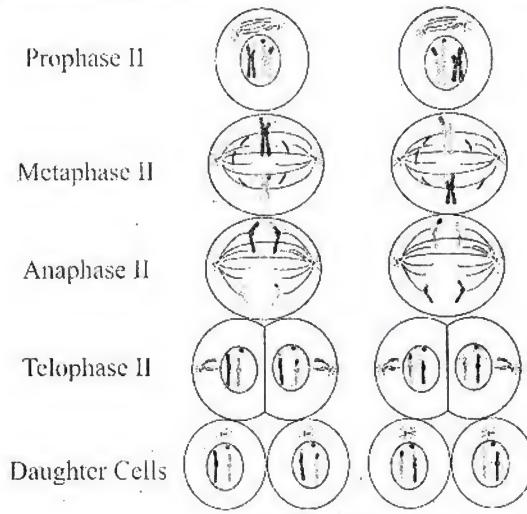


Figure 5.9. Stages in Meiosis-II

**Q.10. Describe significance of meiosis?****Ans. Introduction**

The significance of meiosis for reproduction and inheritance was described in 1980 by German biologist August Weismann.

**(i) Maintenance of chromosome number**

August Weismann noted that meiosis was necessary not only to maintain the number of chromosomes in the next generation but also to produce variations in next generation.

**(ii) Meiosis for sexual reproduction of eukaryotes**

Meiosis is essential for sexual reproduction and therefore occurs in all eukaryotes including single celled organisms that reproduce sexually. Meiosis does not occur in prokaryotes, which reproduce asexually by binary fission.

**(iii) Meiosis in humans**

In human diploid gametes, mother cells or germ line cells undergo meiosis to produce haploid gametes. Male and female gametes unite to form diploid zygote which undergoes repeated mitosis and develops into the new diploid human.

**(iv) Gamete formation in fungi and protozoa**

Many haploid fungi and protozoa produce haploid gametes through mitosis.

**(v) Meiosis in plants**

Plants' life cycle shows alternation of generation. The cells of the diploid sporophyte generation undergo meiosis to produce haploid spores, which grow into haploid gametophyte generation. The haploid gametophyte generation produces haploid gametes through mitosis. The gametes combine to produce the diploid zygote. The zygote undergoes mitosis to become the diploid sporophyte.

**(vi) Meiosis as a source of genetic variations**

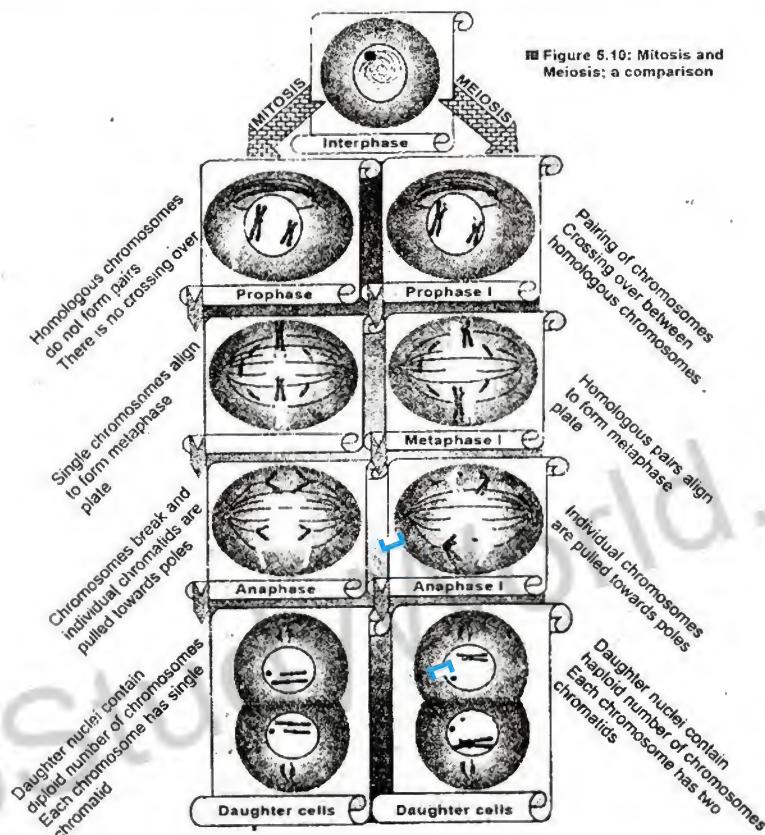
The chromosome pairs of each parent undergo crossing over during meiosis. So daughter cells i.e. gametes have genetic variations. When gametes fuse and form zygote; its genetic make up is different from both parents. Thus meiosis allows a species to bring variations which help organisms to adapt to the changes in environment.

**Q.11. What are common errors of meiosis?**

**Ans.** The normal separation of chromosomes or sister chromatids in meiosis is termed as **disjunction**. When the separation is not normal, it is called non **disjunction**. This result in the production of gametes which have either more or less than the usual number of chromosomes. Such Individuals have 45 or 47 chromosomes in humans.

**Q.12. Describe comparison between mitosis and meiosis**

(Lahore board 2012 G I)


**Q.13. What is apoptosis? What happens in it? Describe its importance.** (Lahore board 2011 G I)

**Ans. Programmed cell death**

"Between 50 billion to 70 billion cells die each day due to apoptosis in an adult human". Apoptosis is one of the main types of programmed cell death.

**Events of apoptosis**

Following is the series of events in apoptosis:

- Cell shrinks and becomes rounded due to the breakdown of the cytoskeleton by enzymes.
- Chromatin undergoes condensation and the nuclear envelope breaks.
- In this way, nucleus spreads in the form of several discrete chromatin bodies.
- The cell membrane makes irregular buds known as **blebs**.
- The blebs break off from the cell and are now called apoptotic bodies, which are then phagocytosed by other cells.

**Causes of apoptosis**

Apoptosis can occur when a cell is damaged, or undergoes stress conditions.

**Significance of apoptosis**

(Lahore board 2011 G I) (short question)

**(i) Removal of damaged cell**

Apoptosis removes the damaged cell, preventing it from getting further nutrients or to prevent the spread of infection.

**(ii) Differentiation of fingers and toes in embryo**

Apoptosis generally gives advantages during development. For example, during the formation of fingers, the cells between them undergo apoptosis and the digits separate.

**Q.14. Write a note on necrosis.** (Lahore board 2011 GI & 2012 G II) (short question)

**Ans. Accidental cell and tissue death**

Necrosis is the accidental death of cells and living tissues, necrosis is less sequential than apoptosis.

### **Causes of necrosis**

There are many causes of necrosis including injury, infection, cancer. Necrosis may occur when a cell is given hypoxic (with less oxygen) environments. Spider bites also cause necrosis in some areas. It may be due to lack of proper care to a wound site.

## Control of necrosis

Necrosis is accompanied by the release of special enzymes from the lysosomes. The lysosomal enzymes break cellular components and may also be released outside the cell to break surrounding cells. Cells that die by necrosis may release harmful chemicals that damage other cells.

# Multiple Choice Questions

- In which stage of the cell cycle each chromosome is duplicated and so it consists of two chromatids?  
(a) G<sub>1</sub>      (b) S  
(c) M      (d) G<sub>2</sub>
- During which phase of mitosis spindles are formed?  
(a) G<sub>2</sub>      (b) Interphase  
(c) Prophase      (d) Metaphase
- In which stage of the cell cycle, the cell is preparing enzyme for chromosome replication?  
(a) G<sub>1</sub>      (b) G<sub>2</sub>  
(c) S      (d) M
- Which of the following stage of cell division is very different for animal and plant cells ?  
(a) Telophase      (b) Metaphase  
(c) Anaphase      (d) Cytokinesis
- Prior to cell division, each chromosome replicates or duplicates its genetic material, the products are connected by a centromere and are called;  
(a) Sister chromosomes  
(b) Homologous chromosomes  
(c) Non-sister chromatids  
(d) Sister chromatids
- The process of mitosis ensures that:



15. If you observe a cell like this one, what phase of mitosis is it?



- (a) Anaphase      (b) Telophase
- (c) Metaphase      (d) Prophase

16. Specific enzymes are synthesized by:

- (a) G<sub>0</sub>      (b) G<sub>2</sub>
- (c) S phase      (d) G<sub>1</sub>

17. The phase which can exist for life is:

- (a) G<sub>0</sub>      (b) G<sub>2</sub>
- (c) S phase      (d) G<sub>1</sub>

18. Chromosomes become double during:

- (a) G<sub>2</sub>      (b) G<sub>0</sub>
- (c) G<sub>1</sub>      (d) S phase

19. The longest phase is:

- (a) Mitotic phase      (b) Meiosis
- (c) Cell cycle      (d) Interphase

20. Type of spindle fibre which attaches the chromosomes is called:

- (a) Kinetochore      (b) Non kinetochore
- (c) Both a and b      (d) Centromere

21. The chromosomes are attached in the equator of spindle in:

- (a) Prophase      (b) Telophase
- (c) Anaphase      (d) Metaphase

22. Chromatids get separated from each other during:

- (a) Telophase      (b) Prophase
- (c) Anaphase      (d) Metaphase

23. Chromatids are condensed during:

- (a) Anaphase      (b) Telophase
- (c) Prophase      (d) Metaphase

24. Uncoiling of chromosomes take place during:

- (a) Prophase      (b) Telophase
- (c) Anaphase      (d) Metaphase

25. The division of nucleus is:

- (a) Mitosis      (b) Karyokinesis
- (c) Cytokinesis      (d) Meiosis

26. Chromosomes are not visible during:

- (a) Prophase      (b) Interphase
- (c) Anaphase      (d) Metaphase

27. The condensation of chromosomes is completed during:

- (a) Telophase      (b) Prophase
- (c) Anaphase      (d) Metaphase

28. Cytokinesis in animals take place by

- (a) Furrow      (b) Phragmoplast
- (c) Telophase      (d) None of the above

29. Which of the following structure is absent in animals?

- (a) spindle      (b) centrioles
- (c) Chromatids      (d) Phragmoplast

30. Cells of which of the followings are called cancer cells?

- (a) Malignant tumor      (b) Benign tumor
- (c) both a and b      (d) None of the above

31. Which of the followings stage is similar in mitosis and meiosis?

- (a) Prophase      (b) Anaphase
- (c) Metaphase      (d) Telophase

32. The exchange of part of chromatids is:

- (a) Chiasmata      (b) Linkage
- (c) crossing over
- (d) None of the above

33. The cell death due to tissue damage is:

- (a) Apoptosis      (b) Necrosis
- (c) Metastasis      (d) Synapsis

34. Necrosis is:

- (a) Division of cells
- (b) Suicide of cells
- (c) Cell death by tissue damage
- (d) Weakness of cells

35. Meiosis discovered in: (Lahore board 2011 G II)

- (a) 1876      (b) 1879
- (d) 1960      (d) 1850

36. Hydra reproduces asexually by:

- (a) Cutting
- (b) Grafting
- (c) Budding
- (d) Binary fission

(Lahore board 2011 G I)

37. In which phase, cell increases the number of its many organelles and grows in size:

- (a) G1
- (b) S phase
- (c) G2
- (d) G0

(Lahore board 2011 G I)

### Answers

1.	b	11.	d	21.	d	31.	d	
2.	c	12.	a	22.	c	32.	c	
3.	a	13.	c	23.	c	33.	b	
4.	d	14.	b	24.	b	34.	c	
5.	d	15.	a	25.	b	35.	a	
6.	b	16.	d	26.	b	36.	c	
7.	c	17.	a	27.	b	37.	a	
8.	d	18.	d	28.	a			
9.	d	19.	d	29.	d			
10.	c	20.	a	30.	A			

### Short Questions

#### Q.1. What is Anaphase?

**Ans.** 1. In this phase, the homologous parts of the chromosomes are separated from each other.

2. The spindle fibres are contracted.
3. The chromosomes start to move towards the opposite poles.
4. Anaphase I is different from anaphase of mitosis because half of the number of chromosomes move towards each pole and each chromosome still has two chromatids.

#### Q.2. Define Apoptosis. (Lahore board 2011 G II)

**Ans.** 1. Apoptosis is the main type of programmed cell death.

2. It involves a series of biochemical events.
3. Between 50-70 billion cells die each day due to apoptosis in an adult human.

#### Q.3. What is Benign? (Lahore board 2011 G I)

**Ans.** Some time mutations occur in genes that control the timing and number of mitosis and the cells continue to divide. It results in growth of abnormal cells called tumors. As long as these tumors remain in their original location, they are called benign.

**Q.4. What is Go Phase?**

**Ans.** In multicellular eukaryotes, cells enter the Go phase from G1 and stop dividing. Cells that have temporarily or permanently stopped dividing are said to have entered a state of quiescence, called G0 phase. Some cells remain quiescent for long periods of time. e.g. neurons. Some cells enter Go phase semi – permanently e.g., some cells of liver and kidneys. Many cells do not enter Go and continue to divide throughout an organism's life. e.g. epithelial cells.

**Q.5. What is Budding?**

**Ans.** Budding is the type of asexual reproduction in which an outgrowth is formed which is ultimately separated and grows in size e.g; yeast (Fungi)

**Q.6. Define Crossing Over.**

**Ans.** During meiosis prophase 1, the exchange of genetic material takes place between homologous chromosomes is called crossing over.

**Q.7. What is G1 Phase?** (Lahore board 2012 G II) (Lahore board 2012 G I)

**Ans.** (Cell cycle starts from G1)

1. Cell increases its supply of proteins.
2. Increases the number of organelles (such that mitochondria, ribosomes)
3. Cell grows in size.

**Q.8. What is G2 Phase?**

**Ans.** In the G2 phase, the cell prepares proteins that are essential for mitosis, mainly for the spindle fibres.

**Q.9. Define Homologous Chromosomes.**

**Ans.** The chromosomes which are similar in morphology (size, structure and position of centromere) is known as homologous chromosomes.

**Q.10. What is Interphase?**

**Ans.** Interphase is the major phase of the cell cycle. It is the time when cell's metabolic activity is very high and it performs various functions. Typically interphase lasts for at least 90% of the total time required for cell cycle.

It is divided into three phases:

1. G1(First gap)
2. S phase (Synthesis)
3. G2(Second gap)

**Q.11. Define Karyokinesis.**

**Ans.** The division of nucleus is known as karyokinesis. The division of nucleus is further sub-divided into 4 phases.

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

**Q.12. Define Mitosis:** (Lahore board 2012 G II)

**Ans.** The type of cell division in which two daughter cells are formed and number of chromosomes remain same as that of parents cells:

**Q.13. What is Kinetochore?**

**Ans.** Each chromosome has kinetochore at centromere. A kinetochore is a complex protein structure that is the point where spindle fibres attach.

**Q.14. What is M-Phase?**

**Ans.** After the G<sub>2</sub> phase of interphase, the cell enters the division phase i.e. M-Phase. It is characterized by mitosis, in which the cell divides into two daughter cells and the number of chromosomes remain same as that of parent cell.

**Q.15. Define Malignant.** (Lahore board 2011 G I)

**Ans.** Some time mutations occur in genes that control the timing and number of mitosis and the cell continue to divide. It results in growth of abnormal cells called tumors. If these tumors invade other tissues, they are called malignant (cancerous) tumors and their cells are called cancer cells.

**Q.16. What is Metaphase?**

**Ans.** When the spindle grows to sufficient length, some of the spindle fibres, known as kinetochore fibres, begin searching for kinetochores to attach. A number of other fibres (non kinetochore) interact with the corresponding fibres from the opposite centrosome.

**Q.17. What is Metaphase plate?**

**Ans.** During metaphase, a kinetochore fibre attaches to kinetochores of the centromeres of the chromosomes arrange themselves along the equator of the cell forming a metaphase plate.

**Q.18. What is Cell cycle?**

**Ans.** The cell cycle is the series of events from the time a cell is produced until it completes mitosis and produces new cell.

The cell cycle consists of two major phase.

1. Interphase
2. Mitotic phase

**Q.19. What is Chiasmata?**

**Ans.** Chiasmata is the region where crossing over occurs. It is a cross like links between two homologous chromosomes. After crossing over, homologous chromosomes separate from one another but remain tightly packed at chiasmata.

**Q.20. Define Necrosis.**

**Ans.** Necrosis is the name given to accidental death of cells and living tissue. There are many causes of necrosis such as:

1. Injury
2. Infection

Necrosis is accompanied by special enzymes from lysosomes.

Cells that die from necrosis may also release harmful chemical that damage other cells.

**Q.21. Define prophase.**

**Ans.** Following changes takes place during prophase of mitotic division:

- (i) Condensation of chromatin
- (ii) Duplication of chromosomes
- (iii) Formation of mitotic spindle
- (iv) Disappearance of nucleolus
- (v) And nuclear envelope

**Q.22. Define Phragmoplast.**

**Ans.** During cytokinesis in plants, the vesicles derived from the Golgi apparatus move to the middle of the cell and fuse to form a membrane-bounded disc called the cell plate or phragmoplast.

**Q.23. What is S-Phase:**

**Ans.** In this phase, the cell duplicates its chromosomes. The DNA molecules of each chromosome is copied, and new protein molecules are attached.

**Q.24. What are Sister chromatids?**

**Ans.** The two chromatids of same chromosome are called sister chromatids. They are attached at same centromere.

**Q.25. Define Spindle.**

**Ans.** The two centrosomes give rise to microtubules by polymerizing the tubulin proteins present in the cytoplasm. The microtubules thus formed are called spindle fibres and the complete set of the spindle fibres is known as mitotic spindle.

**Q.26. What is Synapsis?**

**Ans.** During meiosis prophase 1, the lengthwise pairing of homologous chromosomes is called synapses

Or

The two non-sister chromatids of chromosomes become “zipped” together, forming complexes known as chiasmata, in a process known as synapsis.

**Q.27. Define Tubulin.**

**Ans.** Tubulin is a type of protein present in the cytoplasm. The tubulin monomers give rise to microtubules by polymerization.

**Q.28. What is Tumor?**

**Ans.** Errors in the control of mitosis may cause cancer. All cells have genes that control the timing and number of mitosis. Sometimes mutations occur in such genes and cells continue to divide. It results in growth of abnormal cells called tumors.

**Q.29. Define Metastasis.**

**Ans.** The tumors can send the cancer cells to the other parts in the body where new tumor may form. This phenomenon is called metastasis.

**Q.30. What are different phases of mitosis?**

**Ans. Phases:**

Mitosis has four phases:

1. Prophase      2. Metaphase      3. Anaphase      4. Telophase

**Q.31. Define Cytokinesis?**

**Ans.** Cytokinesis is the division of cytoplasm.

**Q.32. How cytokinesis takes place in animal cells.**

**Ans.**

1. It occurs by a process known as cleavage.
2. A cleavage furrow develops where the metaphase plate (a part of the cytoskeleton) used to be.
3. The ring contracts deepening the furrow and eventually pinching the parent cell into two.

**Q.33. How cytokinesis takes place in plant cell.**

**Ans.**

1. In plant cells it occurs differently.
2. Vesicles derived from the Golgi apparatus move to the middle of the cell and fuse to form a membrane- bounded disc called the cell plate or phragmoplast.
3. The plate grows outward and more vesicle fuse with it. Finally the membranes of the cell plate fuse with the plasma membrane and its contents join the parent cell wall.

**Q.34. What is meiosis? (Lahore board 2012 G II)**

**Ans.** Meiosis is the process by which one diploid eukaryotic cell divides to generate four haploid daughter cells. Diploid means the cell in which chromosomes are in pairs (homologous pairs) while haploid means the cells with half the number of chromosomes i.e. chromosomes are not in the form of pairs.

**Q.35. Define crossing over? (Lahore board 2011 G II)**

**Ans.** During meiosis prophase 1, the non sister chromatids of homologous chromosomes randomly exchange their segments and this phenomenon is called crossing over.

**Q.36. Write Significance of Meiosis.**

**Ans.**

1. Number of chromosomes remains constant in species to species.
2. Variations are produced.
3. Resistance power is produced due to meiosis.
4. Meiosis takes place in gamete formation and spore formation.
5. Each zygote will have a unique genetic make up.